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Short Communication

Endoconidium formation in *Geotrichum candidum*

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Endoconidium formation was observed in five strains of *Geotrichum candidum*. As a vegetative hyphal cell was vacated, an adjacent cell proliferated into it, forming an endoconidium. This type of endoconidium formation resembles holoarthric conidogenesis.

Key Words——conidiogenesis; endoconidium; *Geotrichum candidum*.

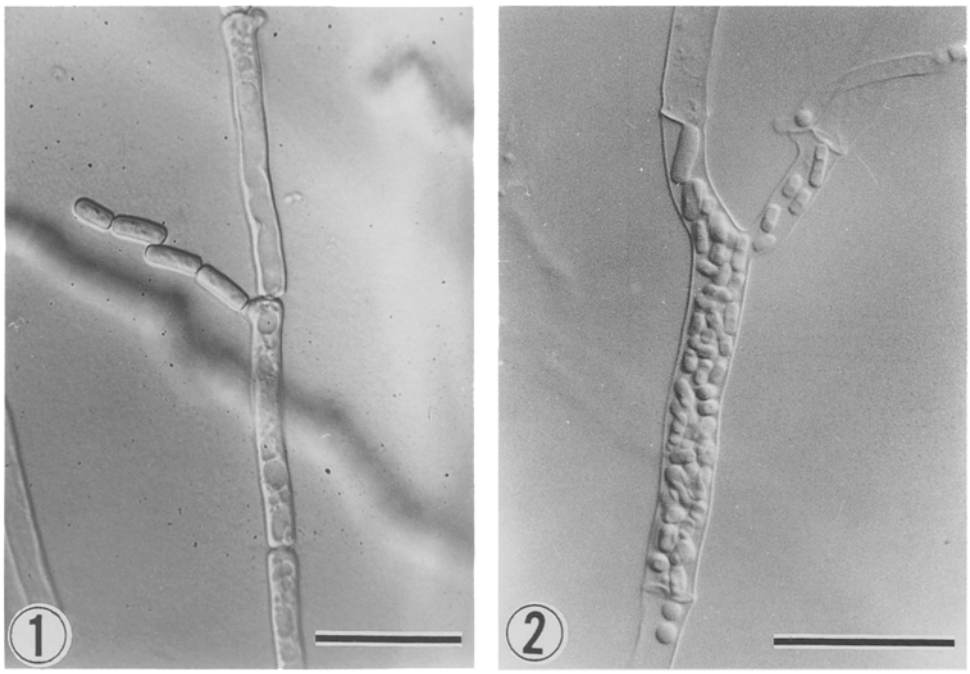
Conidiogenesis of *Geotrichum candidum* Link demonstrates the developmental pattern of holoarthric conidia. Cole and Kendrick (1969) and Cole (1975, 1976) have already investigated this pattern in detail using time-lapse light microscopy and electron microscopy.

Saëz (1969) and Hoog et al. (1986) reported that *G. candidum* produces endoconidia as well as arthroconidia. However, the detailed ontogeny of endoconidia in *G. candidum* is obscure because most research has been limited to holoarthric conidiogenesis.

We have observed endoconidium formation in *G. canididum* in order to clarify this type of conidiogenesis.

Five strains of *G. candidum* were used. The WP01, WP37, WP41 and WP58 strains were isolated from an orange, a carrot, a lemon and a grapefruit, respectively. The characteristic features of these strains closely resemble the description of Carmichael (1957). The other strain was WP26 (IFO 5767). These cultures were preserved in the Laboratory of Crop Science, Tamagawa University, Tokyo, Japan.

Endoconidium formation was observed in a thin glass culture chamber by time-lapse microphotography. The



Figs. 1, 2. Two types of conidium formation of *G. candidum* (WP58) on PDA. 1. Holoarthric conidia. 2. Endoconidia in branched hyphal cell. Bars=30 μm.

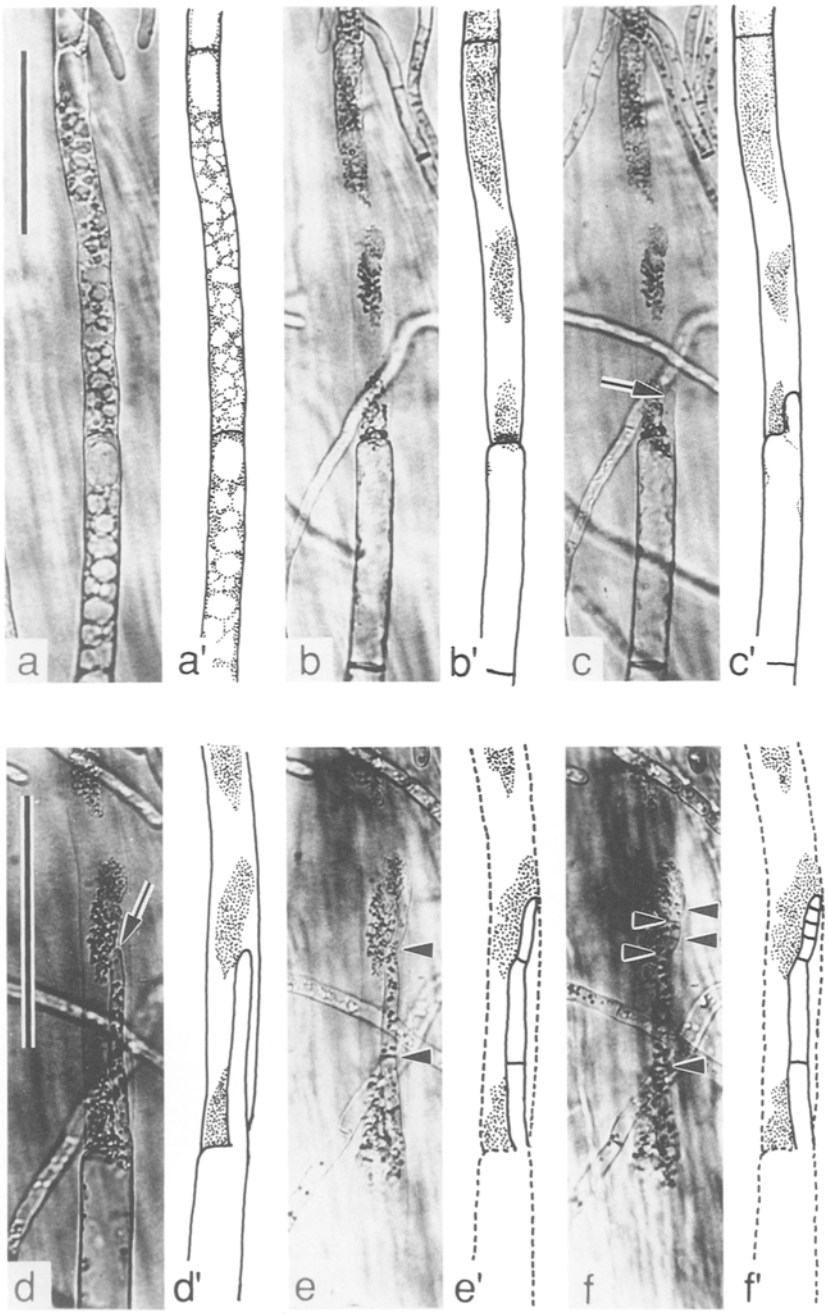
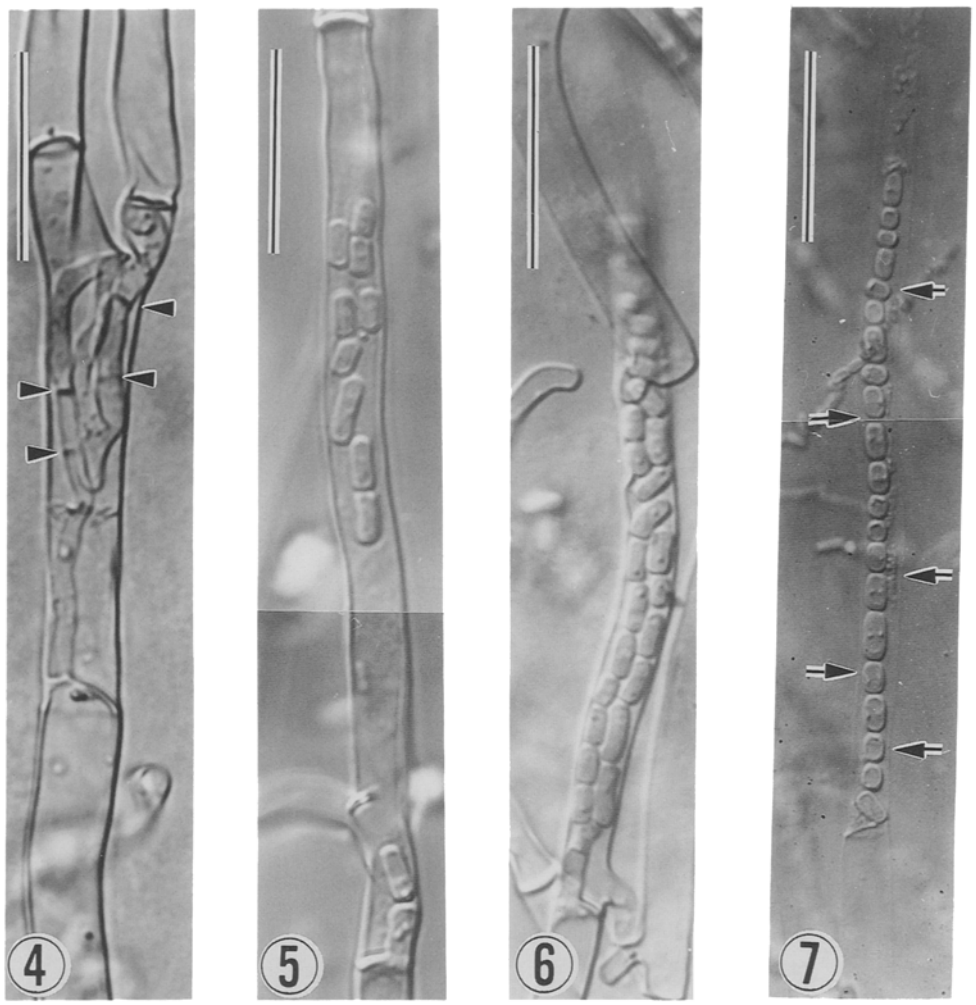


Fig. 3. Endoconidium formation in intercalary hyphal cell. Arrows indicate the proliferated hypha. Arrowheads indicate the septa in the proliferated hypha. Bars=30 μm.

chamber was made from 1.5 mm diam steel wire formed into a 24×50 mm rectangle and placed on a coverslip (24×50 mm). A PDA slab (15×35 mm, ca. 1 mm thick) was put in the chamber. The surface of the PDA slab was inoculated with arthroconidia of *G. candidum*. The chamber was covered with a coverslip and sealed with Sealonfilm (Fuji Photo Film Co., Ltd.). The entire apparatus was incubated at room temperature and endoconidium formation by *G. candidum* was examined under an Olympus BH-2 light microscope. All the *G. candidum* strains frequently produced endoconidia as well as holoarthric conidia (Figs. 1, 2). The holoarthric conidia were cylindrical to ellipsoidal, hyaline, 3.0-15.0×2.5-7.5 μm. The endoconidia were cylindrical, ellipsoidal and subglobose, 3.0-15.0×2.5-7.5 μm (Fig. 2).

The conidiogenesis of endoconidia in *G. candidum* strain WP58 is shown in Fig. 3 with microphotographs and line drawings. Advanced stages of endoconidium formation are shown in Figs. 4-7. The schematic mode is shown in Fig. 8. This conidiogenesis occurred arbitrarily in intercalary (Figs. 3a, 3a', 8a), apical or branched regions of vegetative hyphae. In the early stages of



Figs. 4–7. Endoconidium formation. 4. Septa in proliferated hypha in branched hyphal cell. Arrowheads indicate septa. 5, 6, 7. Later developmental stages of endoconidium formation in intercalary hyphal cell. Arrows indicate the cell wall of the vacated hypha. Bars = 30 μm.

conidiogenesis, the vegetative hyphal cell wall became obscure (Figs. 3b, 3b′, 8b) with humorous granules in the cytoplasm. Subsequently, an adjacent cell proliferated into it (Figs. 3c, 3c′, 8c). The proliferated portion continued to elongate (Figs. 3d, 3d′, 8d) as the cytoplasm of the adjacent cell moved into the newly elongating portion. This proliferating portion appeared to be a hypha. The adjacent cell became obscure and the proliferated hypha formed septa (Figs. 3e, 3e′, 3f, 3f′, 4, 8e, 8f). We observed both septate hypha just before the conversion to endoconidia and disarticulation of a septate proliferated hypha (Figs. 5–7, 8g). However, we failed to obtain a photograph of recently ruptured segments. We observed the same conidiogenesis in the WP01, WP37, WP41 and WR26 stains. Therefore, endoconidium formation is probably common in *G. candidum*.

Saëz (1969) described two modes of endoconidium formation in *G. candidum*. In one mode, the cytoplasm contained in the membrane of the hyphal cell contracted and detached from the exterior of the hypha at an early stage of endoconidium formation. The fragmentation of the cytoplasm gave rise to endoconidia. Saëz (1969) did not explain the roles of the cell wall or membrane in this process. The second mode was characterized by the appearance of a new membrane in the hyphal cell. It surrounded a small quantity of protoplasm and then converted to an endoconidium. In both modes, the protoplasm of the endoconidia originated from the protoplasm of the vacated hyphal cell. However, we were unable to observe these modes in our study.

Our observations showed that endoconidia originate from an elongated hypha advancing into the vacated cell. All the components of the elongated hypha changed to endoconidia. This mode of endoconidium formation appears to be an example of holoarthric conidiogenesis occurring in a pre-existing hypha. The endoconidia germinated in the vacated hyphal cell and demonstrated a new type of endoconidium formation in *G. candidum*.

Literature cited

Carmichael, J. W. 1957. *Geotrichum candidum*. Mycologia **49**: 820–830.

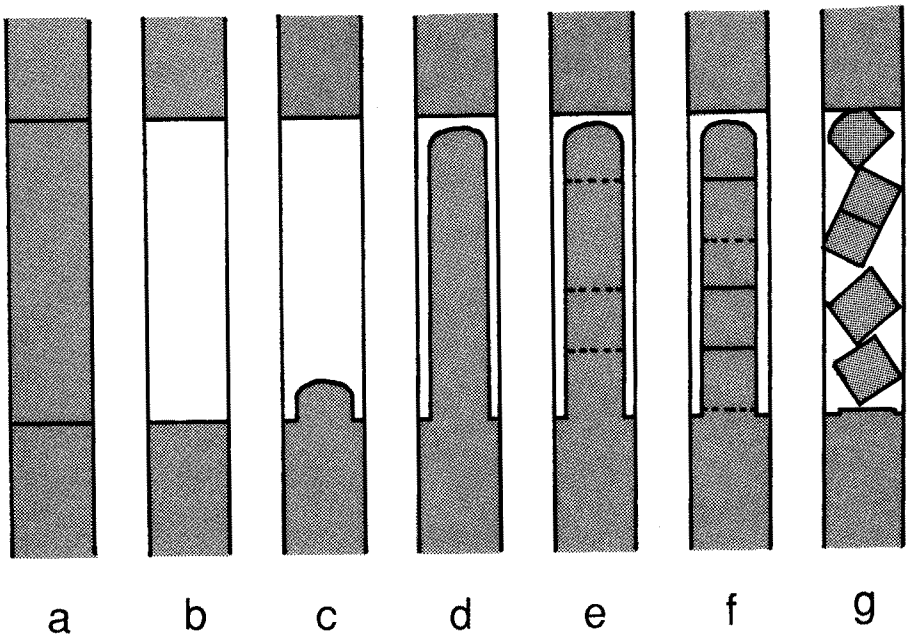


Fig. 8. Schematic explanation of endoconidium formation in intercalary hyphal cell. a, b. The intercalary hyphal cell is vacated. c, d. The adjacent cell proliferated into the vacated cell. e, f. The proliferated portion forms septa. g. Each segment ruptures.

Cole, G. T. 1975. The thallic mode of conidiogenesis in the Fungi Imperfecti. Can. J. Bot. **53**: 2983-3001.

Cole, G. T. 1976. Conidiogenesis in pathogenic hypomycetes 1. *Sporothrix, Exophiala, Geotrichum* and *Microsporum*. Sabouraudia **14**: 81-98.

Cole, G. T. and Kendrick, W. B. 1969. Conidium ontogeny in Hyphomycetes. The arthrospores of *Oidiodendron* and *Geotrichum*, and the endoarthrospores of *Sporedonema*. Can. J. Bot. **47**: 1773-1780.

Hoog, G. S. de., Smith, M. Th. and Gueho, E. 1986. A revision of the genus *Geotrichum* and teleomorphs. Stud. Mycol. **29**: 81-94.

Saëz, H. 1969. Formation d'endospores chez *Geotrichum candidum*. Ann. Parasit Hum. Comp. **44**: 197-204.